526 Rec'd PCT/PTO 17 NOV 2000

FORM PTO-1390 (REV 10-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: TJK/135

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/701160

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US99/10961	19 May 1999	25 MAY 1998

TITLE OF INVENTION: Dextran Starch and Flocculant Combination for Improving Red Mud Clarification

APPLICANT(S) FOR DO/EO/US: BARHAM Scott et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☒ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    *** Certicate of Express Mailing
    *** Postcard
    *** Check for $ 690.00

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/701160	PCT/US99/10961	TJK/135

	CALCULATIONS PTO USE ONLY	
17. ☒ The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 690.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	15 - 20 =	0	X $18.00	$ 0	
Independent claims	2 - 3 =	0	X $80.00	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		0	+ $270.00	$ 0	
TOTAL OF ABOVE CALCULATIONS =				$	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than ☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 690.00	
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 690.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-2126. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Timothy J. Keefer
WILDMAN, HARROLD, ALLEN & Dixon
225 West Wacker Drive
Chicago, Illinois 60606
United States of America

SIGNATURE:
Timothy J. Keefer

NAME
35,567

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR/APPLICANT: BARHAM, et al.

Australian Appl. No: PP 3704

Australian Filing Date: 25 MAY 1998

ENTITLED: Dextran Starch and Flocculant Combination for Improving Red Mud Clarification

OUR REF: TJK/135

Certificate of Express Mailing
"Express Mail Mailing No:

____EL 643767207 US__

I hereby certify that this paper (along with any paper referred to as being attached or enclosed is being deposited with The United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10, on Thursday, November 16, 2000and is addressed to The Assistant Commissioner for Patents, Washington, D.C. 20231

Vicki L. Funches
Print name of person mailing paper

Vicki L. Funches
Signature of person mailing paper

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Box Patent Applications
Washington, D.C. 20231

Sir:

Please amend the subject application as follows:

IN THE SPECIFICATION:

Page 1, please insert the following paragraph at the beginning of the application before the "BACKGROUND OF INVENTION".

--CROSS REFERENCE TO RELATED APPLICATION

This application claims the priority of the Australian patent application Serial No: PP 3704 entitled "*DEXTRAN STARCH AND FLOCCULANT COMBINATION FOR IMPROVING RED MUD CLARIFICATION*" filed on 25 MAY 1998. –

REMARKS

Please amend the above identified application by inserting priority information as set forth above.

Respectfully requested,

Date:November 16, 2000

By:_____
Timothy J. Keefer Reg. No. 35,567

Wildman, Harrold, Allen & Dixon
225 West Wacker Drive
Chicago, IL 60606
Phone. (312) 201-2000
Fax (312) 201-2555

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Scott L. Barham, et al.) Art Unit:
) Examiner:
Serial No: 09/701,160) Docket No.: 5436

Date Filed: 11/17/00

Invention: DEXTRAN STARCH AND FLOCCULANT COMBINATION FOR IMPROVING RED MUD CLARIFICATION

Honorable Commissioner of
Patents and Trademarks
Box No: Official Draftsman
Washington, D. C. 20231

Attention: Official Draftsman

Dear Sir:

It is respectfully requested the enclosed formal drawings for the above-referenced patent application be accepted. Applicants submit herewith two (2) sheets of drawings showing Figures 1 and 2. Approval of these formal drawings is requested. Please deduct any fees from our Deposit Account No.: 14-0105.

Respectfully submitted,

Kelly L. Cummings

Kelly L. Cummings, Reg. No. 39,646
Date 2/8/01

Nalco Chemical Company
Patent & Licensing Department
One Nalco Center
Naperville, Illinois 60563-1198

CERTIFICATE OF MAILING
37 C.F.R. 1.8

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Commissioner of Patents & Trademarks, Box No.: Official Draftsman, Washington, D.C. 20231, on the date below:

2/8/01 Denise Ellison

February 8, 2001 Denise Ellison

O:\LGLPAT\FORMS\PATENT\PTO\Drawings doc

FIG. 1

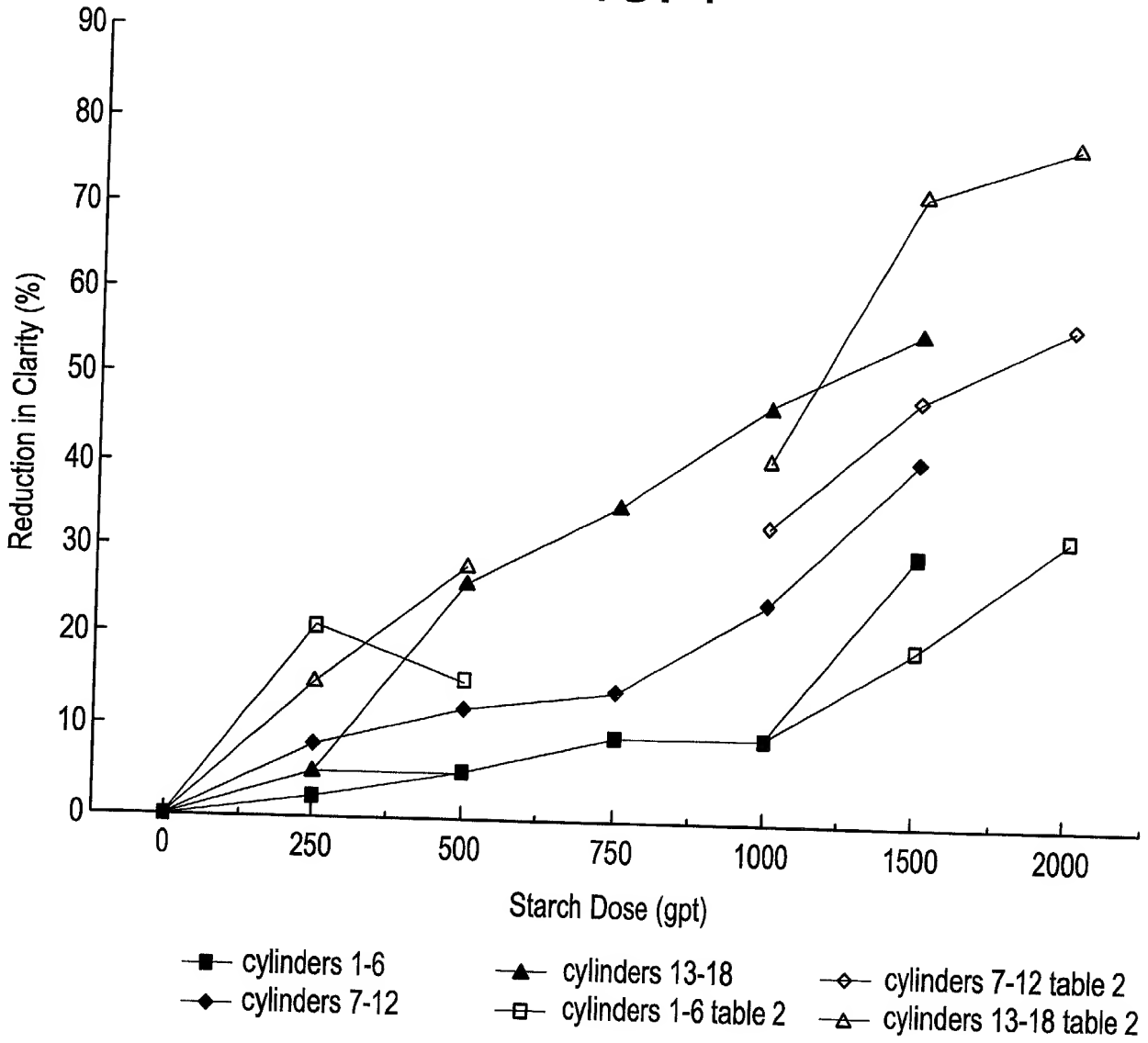
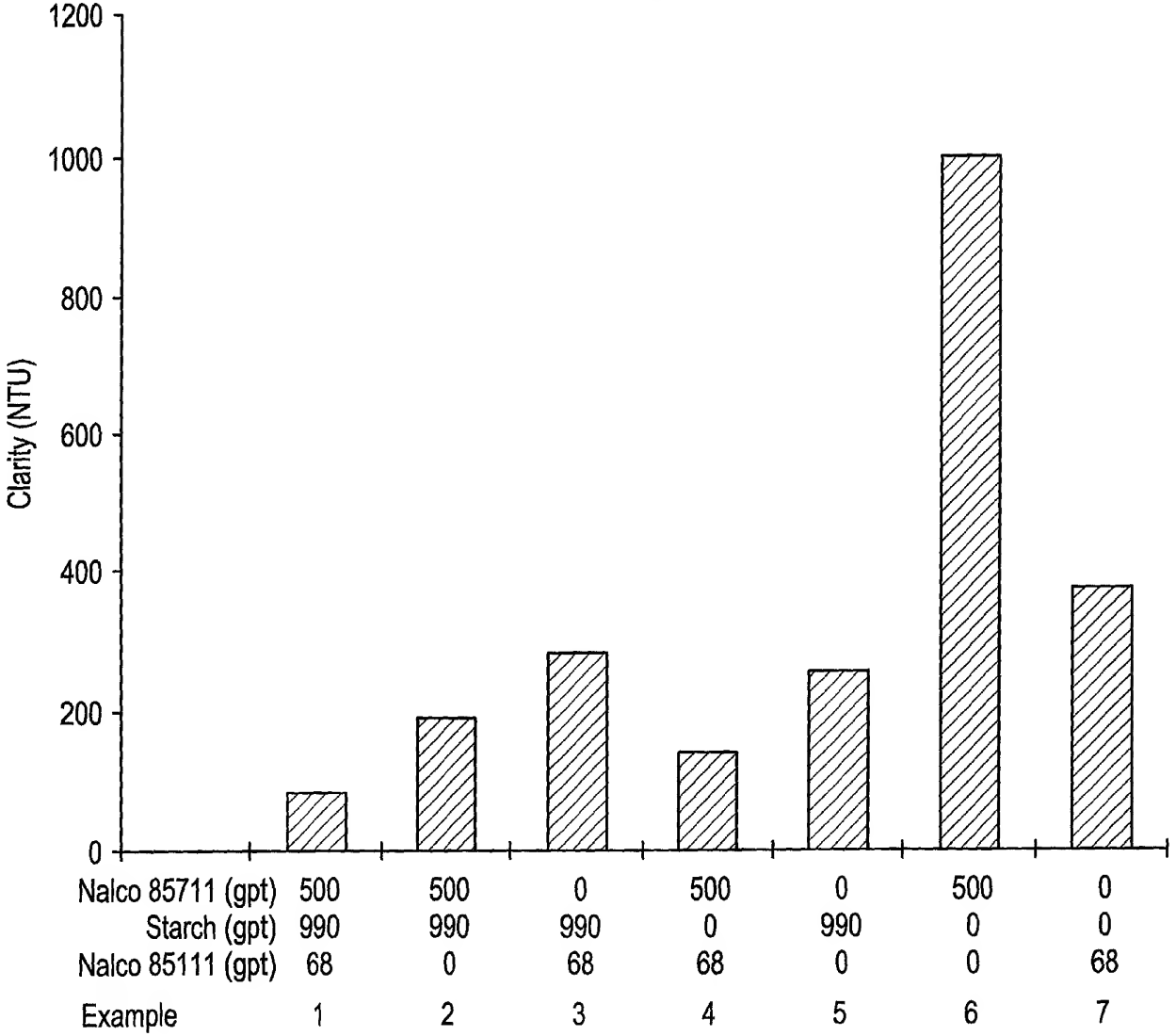


FIG. 2



DEXTRAN STARCH AND FLOCCULANT COMBINATION FOR IMPROVING RED MUD CLARIFICATION

In the Bayer process for the production of alumina, bauxite ore is pulverized, slurred in water, and then digested with caustic at elevated temperatures and pressures. The caustic solution dissolves oxides of aluminum, forming an aqueous sodium aluminate solution. The caustic-insoluble constituents of bauxite ore (referred to as red mud") are then separated from the aqueous phase containing the dissolved sodium aluminate. Solid alumina trihydrate product is precipitated out of the solution and collected as product.

In more detail, the pulverized bauxite ore is fed to a slurry mixer where a water slurry is prepared. The slurry makeup water is typically spent liquor (described below) and added caustic. This bauxite ore slurry is then diluted and passed through a digester or a series of digesters where alumina is released from the ore as caustic-soluble sodium aluminate. The digested slurry is then cooled to about 110°C (about 230°F), typically employing a series of flash tanks wherein heat and condensate are recovered. The aluminate liquor leaving the flashing operation contains from about 1 to about 20 weight percent suspended solids, which solids consist of the insoluble residue that remains after, or is precipitated during, digestion. The coarser solid particles may be removed from the aluminate liquor with a "sand trap" cyclone. The finer solid particles are generally separated from the liquor first by settling and then by filtration, if necessary. The slurry of aluminate liquor and the finer solids is normally first fed to the center well of a mud settler, or primary settler, where it is treated with a flocculant, and as the mud settles, clarified sodium aluminate solution,

referred to as "green" or "pregnant" liquor, overflows a weir at the top. This overflow from the mud settling tank is passed to the subsequent process steps. If the aluminate liquor overflowing the settler contains an unacceptable concentration of suspended solids (at times from about 50 to about 500 mg of suspended solids per liter), it is then generally further clarified by filtration to give a filtrate with no more than about 10 mg suspended solids per liter of liquor. The treatment of the liquor collected after the primary settlement to remove any residual suspended solids before alumina trihydrate is recovered is referred to as a secondary clarification stage.

The clarified sodium aluminate liquor is seeded with alumina trihydrate crystals to induce precipitation of alumina in the form of alumina trihydrate, $AL(OH)_3$. The alumina trihydrate particles or crystals are then separated from the concentrated caustic liquor, and the remaining liquid phase, the spent liquor, is returned to the initial digestion step and employed as a digestant after reconstitution with caustic.

In another section of the Bayer circuit, the settled solids of the primary settler ("red mud") are withdrawn from the bottom of the settler and passed through a countercurrent washing circuit for recovery of sodium aluminate and soda. The countercurrent washing circuit utilizes two or more washers which receive a mud washer feed slurry from either the settler underflow or other washer underflow, as well as any dilution liquor. As noted above, the red mud does not include any coarser particles removed prior to feeding the slurry to the primary or mud settler.

The at least partial separation of the red mud solids from the pregnant liquor at elevated temperatures

by settling or by filtration is expedited by the use of a flocculant. This initial clarification of the pregnant liquor into a clarified liquor phase is referred to as the primary settler state. Flocculating agents improve the separation of insolubles by increasing the rate at which the solids settle, by reducing the amount of residual solids suspended in the liquor, and by decreasing the amount of the liquor in the settled solids phase. Flocculation performance is highly important in the primary settlement stages. Red muds are comprised chiefly of iron oxides (at least about 50 weight percent of the red mud solids), together with silicon oxides, calcium oxides, sodium alumino-silicates, titanium oxides and other materials, and commonly represent from about 5 to about 50 percent of the dry weight of the bauxite ore. Generally these muds are comprised of very fine particles, which hinder the desired rapid and clean separation of red mud particles from the solublized alumina liquor. If the rate of separation is slow, output is materially diminished and overall process efficiency is impaired. If the separation is not clean, the resultant aluminate liquor will require a more extensive treatment to remove residual solids, and/or the alumina trihydrate recovered will contain levels of impurities that are undesirably high for many end uses.

The polysaccharides starch and dextran have, for some time, been used in red mud flocculation. For instance, U.S. Patent No. 3,085,853, April 16, 1963, Lesinski et al., uses native dextrans to increase the rate of sedimentation of finely divided solids in aqueous suspensions and thereby facilitate the separation of such solids. Later synthetic polymeric flocculants became more commonly employed for the Bayer process. U.S. Patent No. 3,390,959 issued July 2, 1968 to Sibert, uses

acrylate homopolymers and copolymers which contain not more than 20% of other ethylenically unsaturated polymerizable polar monomers for the Bayer process. Included in Siber's polar commoners are acrylamide and diethylvinylphosphonate, among others. Diethylvinylphosphonate is the diethyl ester of vinylphosphonic acid, and can be hydrolyzed to the monoethyl ester in caustic solution.

U.S. Patent No. 3,397,953, August 20, 1968, Galvin et al., uses a blend of starch and polyacrylic acid on red mud suspensions, noting that polyacrylic acid alone is not suitable as a flocculating agent. The polyacrylic acids exemplified generally have molecular weights of less than 300,000. The flocculation and sedimentation activity of the blend is exemplified in the primary settler stage of a bauxite process. U.S. Patent No. 3,445,187, May 20, 1969, Sibert, uses synthetic acrylic acid polymer alone to enhance the rate of separation of red mud solids from the aqueous caustic solutions during secondary clarification steps. The synthetic polymer used contains at least about 80 weight percent of the acrylic acid mer unit, and has a molecular weight in excess of 50,000, and preferably in excess of 100,000. U.S. Patent No., 3,541,009, November 17, 1970, Arendt et al., uses a combination of causticized or modified starch, a water soluble polymer, and a caustic alkali to enhance the coagulation, sedimentation and/or filtration of aqueous suspensions of solids, including the settling of red mud from Bayer process liquor. The water soluble polymer is derived from at least one olefinically-unsaturated monomer and has a molecular weight in excess of 100,000.

U.S. Patent No. 3,681,012, August 1, 1972, Sibert, uses acid acrylic polymer most preferably having

molecular weight of at least, 1,000,000, either alone or in combination with starch, for clarification of digested bauxite containing solublized alumina and red mud residues. U.S. Patent No. 4,767,540, August 30, 1988, Spitzer et al., uses a polymer that contains hydroxamic acid groups for the same purpose. U.S. Patent No. 5,008,089, April 16, 1991, Moody et al., uses a combination of dextran and synthetic anionic polymer for flocculating red mud in Bayer process liquors.

U.S. Patent No. 5,217,620, June 8, 1993, Mahoney et al., uses a combination of pullulan, lacatan, rhamsan, or zooglan with a conventional water soluble anionic flocculant for red mud settling.

The synthetic flocculating agents employed for the settling of filtration of red mud are generally water soluble polymers of one or more ethylenically-unsaturated monomers, and have been used together, as noted above, with starch or dextran for aluminate liquor clarification. The synthetic flocculating agents are usually anionic, and the optimum anionic content of such polymer is usually related to the alkalinity of the liquor. In the washing circuit, the early wash liquors have the highest alkalinity and may require a more highly anionic polymer than the later wash liquors.

It is an object of the present invention to provide a more effective flocculation for separating red mud from the red mud-containing liquors, particularly preferably the primary settler liquor, of the Bayer process. It is a preferred object of the present invention to provide an improved method whereby the suspended solids retained in the supernatant phase after flocculation of the red mud-containing liquors, particularly the primary settler liquor, of the Bayer process are diminished. It is further preferred objects of the present invention to

provide a more effective Bayer process wherein flocculation for separating red mud from the red mud-containing liquors particularly the primary settler liquor, is improved by a more complete flocculation of the solids.

DISCLOSURE OF THE INVENTION

In a first aspect, the present invention provides a method for treating Bayer process liquor containing red mud comprising contacting the Bayer process liquor with, in combination, an effective amount of a water soluble synthetic flocculant, dextran and starch prior to separating the red mud from the liquor.

In a second aspect, the present invention provides an agent for treatment of Bayer process liquor containing red mud said agent comprising, in combination, a water soluble synthetic flocculant, dextran and starch in amounts effective to increase separation of the red mud from the Bayer process liquor.

The combination preferably contacts the slurry containing the red mud suspended in Bayer process liquor, or a liquor slurry containing bauxite prior to or during digestion. The dextran, starch and flocculant combination can be added to the Bayer process liquor separately or together provided that in at least one point of the process a combination of all three components are present in the Bayer process liquor. If the three components are added separately, they may be added in any order, but it is preferred to add the starch and polymer (separately or together) prior to the addition of the dextran. In preferred embodiments, the starch and polymer are added to the process upstream from the point of addition of the dextran.

Once the components of the combination are added, they are mixed sequentially with the Bayer process liquor, and the red mud contained in the Bayer process liquor is removed by sedimentation, centrifugation or filtration.

Water-soluble synthetic flocculants which may be used in combination with dextran and starch include, but are not limited to acrylates, homopolymers of acrylic acid, copolymers of acrylic acid and acrylamide and copolymers of acrylic acid and acrylamide modified to contain a hydroxamic acid or acrylic acid moieties. Particularly preferred are ammonium acrylate polymers because of their replacement ratio and apparent synergy. The red mud thus treated may be separated from the liquor phase using a separator selected from the group consisting of settlers, thickeners, centrifuges and filters.

Preferably, the combination which contacts the Bayer process liquor is used in an amount of from about 0.01 to about 10 grams per liter of Bayer process liquor treated. The combination is more preferably used in an amount of from about 0.1 to about 2 grams per liter of liquor treated. The combination may contact the Bayer process liquor anywhere. For example the combination may contact the Bayer process liquor at a point selected from the group consisting of the primary settler feed, bauxite pretreatment, bauxite digestion and flash tanks. As stated above the dextran, starch and polymer may be added to the liquor separately or together. Preferably the starch and polymer may be added to the liquor separately as far back upstream from the addition of dextran as possible (the further back, the better for clarity reduction). For example the starch and polymer can be added as one solution or separately to a thickener feed

line followed by addition of dextran to the feed line just prior to the feedwell or into the feedwell via sparges. Preferably the combination contacts the Bayer Process liquor in the primary settler feed.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will now be described by way of reference to the following non-limitative examples and drawings in which:

Figure 1 is a graph comparing dosage of starch in grams per tonne (GPT) to reduction in clarity and

Figure 2 is a graph comparing additions of various constituents in grams per tonne and their effect on clarity.

BEST MODE FOR CARRYING OUT THE INVENTION

To evaluate the effectiveness of the combination, settling tests were completed in a waterbath with temperature maintained at 96°C. Eighteen (18) cylinder of identical mud/liquor characteristics were tested during one experiment.

High Molecular Weight Homopolmyer Ammonium Acrylate (hereinafter referred to as Polymer A) with a molecular weight greater than 10 million and supplied by Nalco was diluted in spent liquor to a concentration of 1.5 gpl (0.15%) by introducing the neat polymer to the vortex produced by a cage stirrer at 800 RPM and mixing four five (5) minutes. Dextran (hereinafter referred to as Polymer B) was diluted in lake water to a concentration of either 5 or 10 gpl (0.5 or 1.0%) by gentle mixing by shaking the bottle by hand. Starch was supplied as a 400 gpl (40%) solution and diluted with lakewater to 100 gpl (10%), and then further diluted with spent liquor to a final concentration of 20 gpl (2%) again by shaking the bottle by hand.

Polymer and Starch solutions were added together and the cylinders mixed using a gang plunger which allows six (6) cylinders to be tested at one time. After addition and mixing of polymer and starch solutions the dextran solution was added and further mixing completed using the gang plunger.

Settling rate is presented in m/h and determined by measuring the time for flocculated mud particles to settle from 1000 ml to 600 ml in a 1000 ml cylinder.

Clarity was determined by decanting 250 ml of supernatant from the top of the settled cylinder after 30 minutes, adding 75 ml of 10N NaOH and boiling mixture to negate any precipitation of hydrate. After boiling, the liquor was cooled and passed through a turbidity meter and clarity determined and presented in NTU units.

The results of these tests showing the various synthetic flocculant/starch/dextran dosages are shown in tables 1 and 2.

TABLE 1

Cylinder	Plunges After Polymer/ Starch Addition	Plunges After Dextran Addition	Polymer Dose (ml)	Polymer Dose (gpt)	Starch Dose (ml)	Starch Dose (gpt)	Dextran Dose (ml)	Dextran Dose (gpt)	Settling Rate (m/h)	Clarity (NTU)	Reduction in Clarity (%)
1	20	10	4.0	150	0.0	0	0.4	100	2.9	220	0
2	20	10	4.0	150	0.5	250	0.4	100	3.4	215	2
3	20	10	4.0	150	1.0	500	0.4	100	4.1	210	5
4	20	10	4.0	150	1.5	750	0.4	100	4.1	200	9
5	20	10	4.0	150	2.0	1000	0.4	100	4.5	200	9
6	20	10	4.0	150	3.0	1500	0.4	100	4.9	155	30
7	20	10	4.0	150	0.0	0	0.8	200	3.8	245	0
8	20	10	4.0	150	0.5	250	0.8	200	4.4	225	8
9	20	10	4.0	150	1.0	500	0.8	200	4.4	215	12
10	20	10	4.0	150	1.5	750	0.8	200	4.5	210	14
11	20	10	4.0	150	2.0	1000	0.8	200	4.5	185	24
12	20	10	4.0	150	3.0	1500	0.8	200	5.1	145	41
13	20	10	4.0	150	0.0	0	1.6	400	4.5	215	0
14	20	10	4.0	150	0.5	250	1.6	400	4.6	205	5
15	20	10	4.0	150	1.0	500	1.6	400	5.4	160	26
16	20	10	4.0	150	1.5	750	1.6	400	5.6	140	35
17	20	10	4.0	150	2.0	1000	1.6	400	5.8	115	47
18	20	10	4.0	150	3.0	1500	1.6	400	6	95	56

TABLE 2

Cylinder	Plunges After Polymer/ Starch Addition	Plunges After Dextran Addition	Polymer Dose (ml)	Polymer Dose (gpt)	Starch Dose (ml)	Starch Dose (gpt)	Dextran Dose (ml)	Dextran Dose (gpt)	Settling Rate (m/h)	Clarity (NTU)	Reduction in Clarity (%)
1	30	10	6.0	225	0.0	0	0	0	1.7	235	0
2	30	10	6.0	225	0.5	250	0	0	2.2	185	21
3	30	10	6.0	225	1.0	500	0	0	3.2	200	15
4	30	10	6.0	225	2.0	1000	0	0	3.6	215	9
5	30	10	6.0	225	3.0	1500	0	0	4.6	190	19
6	30	10	6.0	225	4.0	2000	0	0	4.6	160	32
7	30	10	6.0	225	0.0	0	1	250	3	210	0
8	30	10	6.0	225	0.5	250	1	250	3.7	200	5
9	30	10	6.0	225	1.0	500	1	250	4.5	200	5
10	30	10	6.0	225	2.0	1000	1	250	4.6	140	33
11	30	10	6.0	225	3.0	1500	1	250	6.4	110	48
12	30	10	6.0	225	4.0	2000	1	250	4.6	90	57
13	30	10	6.0	225	0.0	0	2	500	4.1	230	0
14	30	10	6.0	225	0.5	250	2	500	4.1	195	15
15	30	10	6.0	225	1.0	500	2	500	4.8	165	28
16	30	10	6.0	225	2.0	1000	2	500	4.5	135	41
17	30	10	6.0	225	3.0	1500	2	500	5.4	65	72
18	30	10	6.0	225	4.0	2000	2	500	5	50	78

The results are also shown in the attached Figure 1. It can be seen from the figure that including dextran and polymer in a starch flocculant combination resulted in a marked improvement in clarity.

To highlight the synergistic effect of the various constituents of the treatment agent, further tests were carried out with various dosages of the water soluble synthetic flocculant, starch and dextran. The synthetic flocculant (hereinafter referred to as Nalco 85111) was a high molecular weight ammonium acrylate with a molecular weight greater than 10 million made up at 0.18% solution in lake water. The starch was made up to 1.1% in spent liquor as per conventional plant practice. The dextran (hereinafter referred to as Nalco 85711) had a molecular weight of greater than 500,000 and was made up as a 1% solution in lake water.

As with the previous examples, the polymer and starch were added first. The combination of slurry, starch and Nalco 85111 were mixed by plunging 10 times and then the Nalco 85711 dextran added and mixed by plunging a further five times.

The clarity tests were conducted in a manner similar to the aforementioned examples, however, the clarity was determined after five minutes to allow the differences in dosages to be more clearly identified.

Results of the tests are shown in Table 3 and figure 2.

TABLE 3 - COMPARATIVE EXAMPLES

Eg	85111 Conc (gpl)	85111 Dose (ml)	Starch Conc (gpl)	Starch Dose (ml)	85711 Conc (gpl)	85711 Dose (ml)	Feed Solids (gpl)	Floc Dose (gpt)	Starch Dose (gpt)	85711 Dose (gpt)	Srate T600 (secs)	Srate (m/h)	O/F Clarity NTU
1	1.8	1.5	11	9	1	20	40	68	990	500	45	11.1	80
2	1.8	0	11	9	1	20	40	0	990	500	300	1.7	185
3	1.8	1.5	11	9	1	0	40	68	990	0	57	8.8	275
4	1.8	1.5	11	0	1	20	40	68	0	500	64	7.8	135
5	1.8	0	11	9	1	0	40	0	990	0	600	0.8	250
6	1.8	0	11	0	1	20	40	0	0	500	-	<0.2	1000
7	1.8	1.5	11	0	1	0	40	68	0	0	80	6.3	370

The synergistic effect of the three constituent making up the treatment agent will be clear from these results and in particular figure 2. As can be seen from this figure, in each example where one of the constituent is left out, there is a substantial reduction in the clarity determined after five minutes. The closest comparative example is Example 4 in which only dextran and the water soluble synthetic flocculant are added to the Bayer process liquor. In this instance, clarity is measured at 135 NTU. This is nearly 70% higher than Example 1 using the proposed treatment agent (clarity 80 NTU). Other comparative examples are between two and 12 times less effective.

It will be clear to persons skilled in the art therefore that the combination of water soluble synthetic flocculant, dextran and starch provides a significant increase in the effectiveness of separation processes particularly sedimentation, centrifugation and filtration which is unrecognized and hitherto unsuspected from the prior art.

This invention also relates to the use of the combination of water soluble synthetic flocculant, dextran and starch for promoting coagulation or flocculation in other mineral slurries such as coal, kaolin, copper, precious metals, phosphate, taconite and refuse tailings obtained from these ores.

Changes can be made in the composition, operation and arrangement of the method of the present invention described herein without departing from the concept and scope of the invention as defined in the following claims.

CLAIMS

1. A method for treating Bayer process liquor containing red mud comprising contacting the Bayer process liquor with, in combination, an effective amount of a water soluble synthetic flocculate, dextran and starch prior to separating the red mud from the liquor.

2. A method according to claim 1 wherein the red mud is separated from the liquor by a process selected from the group consisting of sedimentation, centrifugation and filtration.

3. A method according to claim 1 wherein the water soluble synthetic flocculant, dextran and starch combination is used in an amount of from about 0.01 to about 10 grams per liter of liquor treated.

4. A method according to claim 1 wherein the water soluble synthetic flocculant, dextran and starch combination is used in an amount of from about 0.1 to about 2 grams per liter of liquor treated.

5. A method according to claim 1 wherein the water soluble synthetic flocculant, dextran or starch are added separately or together to the Bayer process liquor.

6. A method according to claim 1 wherein the water soluble synthetic flocculant and starch are added together to the Bayer process liquor and one solution and separate from the dextran.

7. A method according to claim 1 wherein the water soluble synthetic flocculant and starch are added together to the Bayer process liquor upstream of the dextran addition to the Bayer process liquor.

8. A method according to claim 1 wherein the water soluble synthetic flocculant, dextran and starch

combination contacts the Bayer process liquor at one or more points selected from the group consisting of primary settler feed, bauxite pretreatment, bauxite digestion and the flask tanks.

9. A method according to claim 1 wherein the step of separating the red mud from the liquor is carried out by a separator selected from the group consisting of settlers, thickeners, centrifuges and filters.

10. A method according to claim 1 wherein the water soluble synthetic flocculant is selected from the group consisting of homopolymers of acrylic acid, copolymers of acrylic acid and acrylamide, copolymers of acrylic acid and acrylamide modified to contain a hydroxamic acid moiety and copolymers of acrylic acid and acrylamide modified to contain an acrylic acid moiety.

11. An agent for treatment of Bayer process liquor containing red mud said agent comprising, in combination, a water soluble synthetic flocculant, dextran and starch in a quantity sufficient to increase separation of the red mud from the Bayer process liquor.

12. An agent as claimed in claim 11 wherein the water soluble synthetic flocculant, dextran and starch combination is used in an amount of from about 0.01 to about 10 g/l of liquor treated.

13. An agent as claimed in claim 11 wherein the water soluble synthetic flocculant, dextran and starch combinations is used in an amount of from 0.1 to about 2 g/l of liquor treated.

14. An agent as claimed in claims 11 wherein the agent comprises two components, a first component comprising water soluble synthetic flocculant and starch and a second component comprising dextran, the two components being suitable for separate addition to the Bayer process liquor.

15. An agent as claimed in claim 11 wherein the water soluble synthetic flocculant is selected from the group consisting of homopolymers of acrylic acid, copolymers of acrylic acid and acrylamide, copolymers of acrylic acid and acrylamide modified to contain hydroxamic acid moiety and copolymers of acrylic acid and acrylamide modified to contain an acrylic acid moiety.

FIG. 1

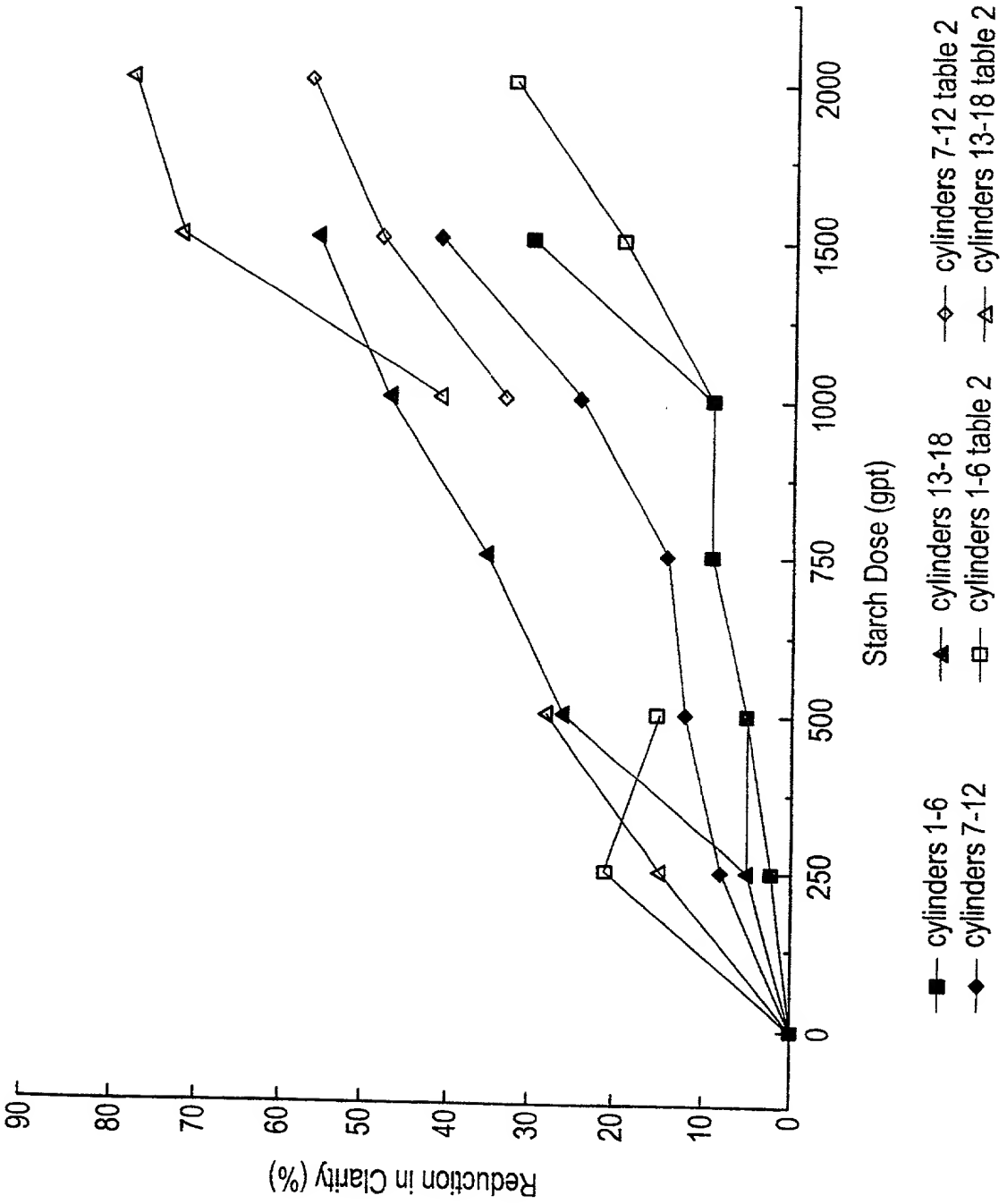
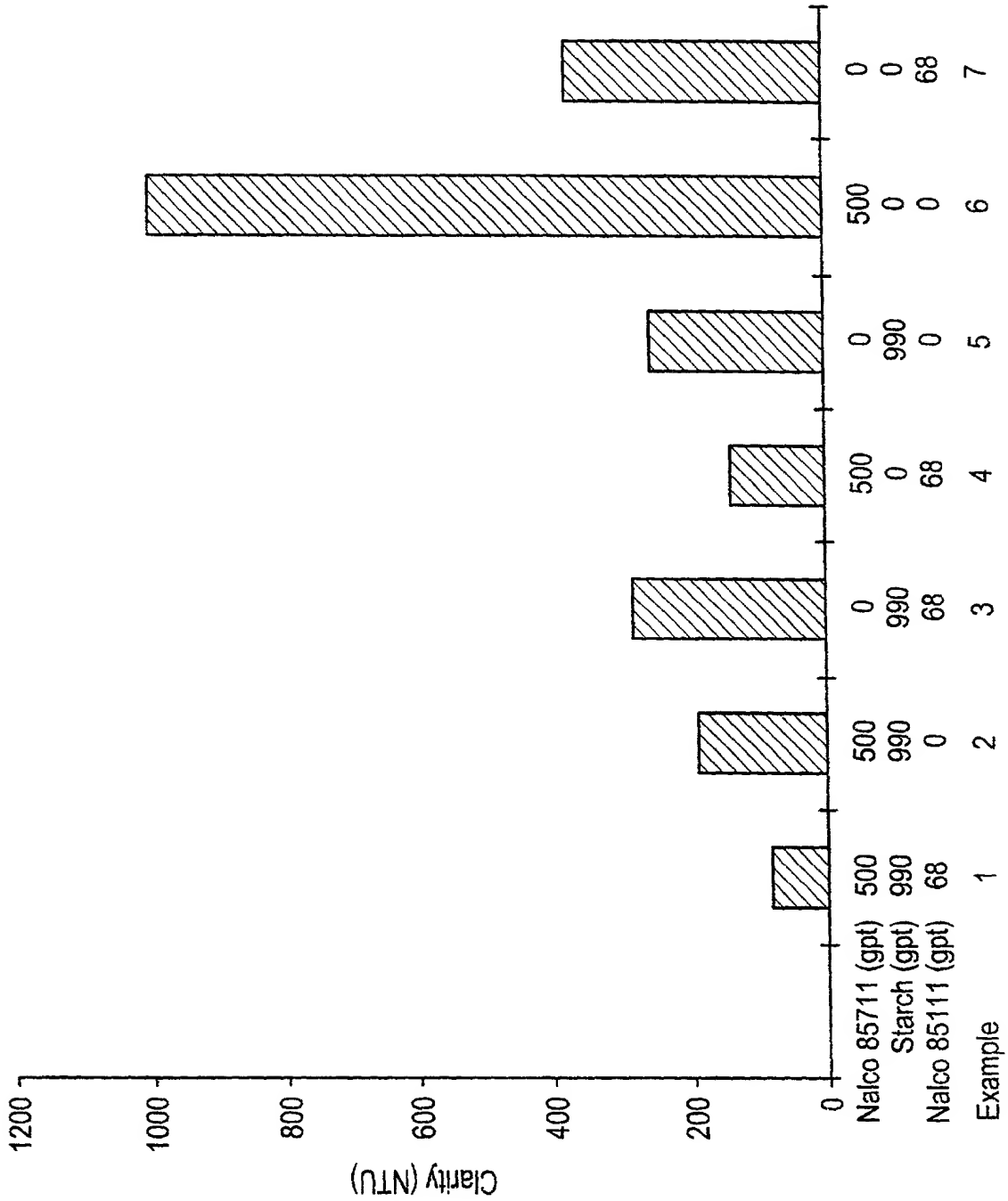


FIG. 2


Clarity (NTU)
1200
1000
800
600
400
200
0
Nalco 85711 (gpt)
Starch (gpt)
Nalco 85111 (gpt)
Example
500 990 68 1
500 990 0 2
0 990 68 3
500 0 68 4
0 990 0 5
500 0 0 6
0 0 68 7

Case No. 5436

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I, Scott Barham and James Morton Tippett, hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name, I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which the patent is sought on the invention entitled DEXTRAN, STARCH AND FLOCCULANT COMBINATION FOR IMPROVING RED MUD CLARIFICATION

the specification of which

(check one) ( ) is attached hereto
(X) was filed on 11/17/00 as

Application Serial N° 09/701,160
and was amended on _____

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications		Priority Claimed	
US99/10961 (Number)	PCT (Country)	19/5/99 (Day/Mo./Yr. filed)	(X) Yes ( ) No
PP3704 (Number)	Australia (Country)	25/5/98 (Day/Mo./Yr. filed)	(X) Yes ( ) No
(Number)	(Country)	(Day/Mo /Yr. filed)	( ) Yes ( ) No

I hereby claim the benefit under Title 35, United States Code, §120, of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial N°)	(Filing Date)	(Status - Patented, pending, abandoned)
(Application Serial N°)	(Filing Date)	(Status - Patented, pending, abandoned)

Case No. 5436

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent & Trademarks Office connected therewith.

Thomas M. Breininger, Reg. No. 29,897
Kelly L. Cummings, Reg. No. 39,646
Margaret Meta Brunum, Reg. No. 33,655
Michael B. Martin, Reg. No. 37,521

SEND CORRESPONDENCE TO:

Kelly L. Cummings
Patent & Licensing Department
Nalco Chemical Company
One Nalco Center
Naperville, Illinois 60563-1198

Direct telephone calls to:

Kelly L. Cummings
Patent Department
630-305-2328

I further declare that all statements, data, and figures made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

I also believe that disclosures, statements, data, and figures included in the above mentioned specification and claims are, to my best knowledge, accurate and truthful.

Full name of sole or first inventor Scott Barham

Inventor's Signature

Date _____ Country of Citizenship Australia

Residence ~~Palmyra, WA~~ FLOREAT W.A.

Post Office Address ~~4 McGregor Rd., Palmyra, WA 6157~~ 45 ORREL AVE, FLOREAT 6014

Full name of second inventor James Morton Tippett

Inventor's Signature

Date 12/1/01 Country of Citizenship Australia

Residence Oatley, NSW 2223 Australia

Post Office Address 16 E Russell St., Oatley, NSW 2223 Australia

Full name of third inventor

Inventor's Signature

Date _____ Country of Citizenship

Residence

Post Office Address

Full name of fourth inventor

Inventor's Signature

Date _____ Country of Citizenship

Residence

Post Office Address

I JOSEPH VIZZONE Public Notary of Sydney, Australia certify that this document was signed in my presence on the 12th day of January 2001 by ~~Joe~~ JAMES MORTON TIBBETT

IN FAITH TESTIMONY AND WITNESS whereof I have affixed my hand and seal

In the United States Patent and Trademark Office

Applicant: Barham, et al.	)	Group Art Unit:	
Serial No.: 09/701,160	)	Examiner:	
Date Filed: 11/17/00	)	Case No.:	5436

For: DEXTRAN STARCH AND FLOCCULANT COMBINATION FOR IMPROVING RED MUD CLARIFICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

ASSOCIATE POWER OF ATTORNEY

Dear Sir:

Please recognize Kelly L. Cummings, Reg. No. 39,646 as my associate in this case with full power of substitution.

Respectfully submitted,

Timothy J. Keefer, Reg. No. 35,567

Wildman, Harrold, Allen & Dixon
225 West Wacker Drive
Chicago, Illinois 60606
United States of America
(312) 201-2000
Date: 2/7/01